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value and uses.



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BARNYARD MANURE

ITS VALUE AND USES

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BARNYARD MANURE

ITS VALUE AND USES

In the older civilized countries of the world the excrements of domestic animals have been used for centuries to enrich the cultivated soils. Long ago the Romans recognized the value of such manure and wrote directions for its use. The necessity for producing better crops to meet the needs of congested populations has led the agriculturists of Italy, France and Great Britain to save and return to the soil the waste products of live stock husbandry years before the need was felt in our own country. The virgin soil of the Western Continent did not need to be fed at the first in order to make it produce harvests. By the time fertility began to decline in the Atlantic Coast States new areas, including the fertile prairies of the West, became accessible and many an Eastern farm, grown poorer in soil fertility for lack of plant food and proper utility of its resources, was abandoned for the new and more productive lands of the Mississippi Valley and the plains beyond. Some of those who remained behind to farm the best of the Eastern lands had brought from Europe habits of thrift based on a knowledge of good soil husbandry. The fertility of many of the best Eastern farm lands has been maintained and even increased by the judicious use of waste products from the live stock industries of this country. Barnyard manure has been a most valuable asset for the gardener and farmer of the East for decades, but until recently the farmers of the prairie states looked upon it as a nuisance, something to be gotten rid of as cheaply as possible with no thought of returning it to the soil from which its ingredients sprang. The Kansas farmer hauled it away from his farm barns and piled it in some out of the way place to rot only a few years ago. If the feed lots of Colorado stock farmers become too deep with manure for the comfort of his animals, he moves the fence to cleaner ground but leaves the manure to leach and rot just where it was dropped, even to this day. In Ohio, the borderland between the East and West, the spectacle of dairy barns built on the river banks so that the semi-liquid manure could be more easily pushed down the slope and be

swept away by the river, has been commented upon. And there have been farmers, too, who did not trouble themselves to treat their larger fields with barnyard manure but contented themselves with heavy applications to their gardens and truck patches near the barnyard, and this happened only forty years ago or less.

There has been a gradual but pronounced change of ideas regarding the value and use of barnyard manure among the men who handle it, during the last two decades. This has been brought about mainly by the facts discovered in scientific investigations at the agricultural experiment stations. The agricultural colleges and the agricultural papers have greatly aided the experiment stations to bring these facts home to the men most benefited by their practical application, while the rapid development of machinery and appliances for rendering the work of handling and applying barnyard manure less irksome and more profitable, has led many a man to make good use of that which he once wasted. Let us examine the facts as they now appear in regard to the value and uses of barnyard manure.

The solid and liquid excrements of domestic animals, together with the litter used as bedding or for absorbing the liquid part, constitute barnyard manure. It is quite variable in composition. The age, condition and kind of animal producing the manure, the quality of food fed and of the litter used for bedding are all factors which influence the composition of barnyard manure. The value of it, measured in results to the user, depends on its initial composition, the losses it may sustain before it becomes a part of the soil, the nature of the soil to which it is applied, the time of application, and the manner of application.

BARNYARD MANURE CONTAINS PLANT FOOD.

The ingredients found in barnyard manure which are recognized as plant food and therefore have a market value, are nitrogen, phosphorus and potash. They are present in the form of compounds, some of which are soluble and some insoluble in water. The liquid excrement of farm animals contains most of the potash and slightly more than half of the total nitrogen voided, but only a trace of the phosphorus is found in it. On account of the readiness with which plants can use it, and because nitrogen has a higher market value than either potash or phosphorus, the liquid portion of manures is thought more valuable than the solid portion, so far as actual plant food is concerned. It has the disadvantage of being more easily lost by leaching, and as the nitrogen is present in easily fermented forms it may be wholly or partly lost in the form of gases.

The kind of litter used for bedding may influence the percentage

of plant food to quite an extent. Sawdust and shavings, while they are good absorbents of the liquid manure, and greatly facilitate its application to the soil, are poor in the plant food elements most wanted. Straw from wheat, oats and rye is better and quite readily decays in the soil, but peat, because of the larger percentage of nitrogen it contains, is a still better bedding material, if the plant food value of manure is considered.

The manures from different kinds of farm animals have been found to vary somewhat in composition, mainly in the amount of water contained. Sheep manure contains less water than that from horses, swine or cattle. Cow manure contains more water than any of the others. A mixture of all four kinds has been reported by Wolff to contain water 75 per cent, nitrogen 0.45 per cent, phosphoric acid 0.21 per cent, and potash 0.52 per cent. Although animals at work or in process of fattening, giving milk, or making growth, produce manures of varying composition, "the average value of the manures produced by a given live weight of animals under farm conditions is practically the same irrespective of the kind of animal considered."*

Regarding the portion of fertilizing ingredients or plant food recovered in the manure from the food consumed by the animal, Prof. Vivian says, "Taking into account the ratio between matured and young stock, milch cows and non-milk producing animals, as found on the average farm, it is conservative to assume that at least eighty (80) per cent of the nitrogen, phosphoric acid and potash present in the materials fed on the farm is voided by the animals in the solid and liquid excrement." It follows then that where a stock farmer feeds most of the farm crops to animals and buys additional feeds in the form of concentrates, he can add to the store of plant food in his soil if he so handles the manure produced by his animals that little or none of its value is lost before applying it. That this actually happens on dairy farms in the Eastern States has been frequently noticed. It is the chief reason why intensified animal husbandry is so often relied upon to build up the fertility of a run down farm. **The correct method of applying manure to the soil by means of the mechanical spreader has made this system a sure success.**

BARNYARD MANURE IMPROVES THE PHYSICAL CONDITION OF THE SOIL.

Next to the actual plant food added the most important benefit to the soil from the use of barnyard manure is the changed physical condition. Humus is formed by the decay of solid excrements and bedding. Humus added to soils composed mainly of very fine par-

*The Principles of Manuring, by Prof. Alfred Vivian.

tibles, such as clays and clay loams, makes them more porous and friable. Surplus water finds its way more quickly below the roots of plants, while in times of drought the capillary water stored in the spongy humus mixed with the soil grains is available to plant roots near the surface. The soil also shows less tendency to open in large cracks permitting the escape of moisture from below when it is most needed by crops.

Coarse strawy manure has a very beneficial effect on tenacious clay soils. Aeration is promoted, the soil is more easily cultivated, and the decay of the coarse material generates some heat which helps to raise the temperature of the soil. On account of their tendency to hot fermentation the manures from horses and sheep are thought to be more beneficial in such soils than that from hogs and cattle.

In porous soils through which the water passes too rapidly, decayed manure helps to bind the loose particles together, acts as a sponge to absorb and hold water which otherwise would sink below the feeding ground of plant roots, and makes evaporation from the surface less rapid. Sandy soils are already well warmed and aerated as a general thing, and the decay of manure is more rapid in them than is sometimes desirable for the good of the crops grown. To such soils rotted and half rotted manure applied just previous to planting time has been found better than applications of fresh manure. Fermentation and decay are too much hastened in loose sandy soils by fresh barnyard manure, especially if from horses and sheep.

If the mechanical condition of any soil is to be improved by barnyard manure, the thoroughness with which it is shaken apart in spreading on the surface of the soil and cultivated into it, is of the utmost importance. Each particle of soil ought to come in contact with a particle of manure, but this cannot be where great chunks are scattered over a field by hand and plowed under with difficulty. **The good results in soil texture are more quickly apparent and more cheaply produced where machinery is used to tear apart and scatter the manure before mixing it into the soil.**

BARNYARD MANURE HELPS TO UNLOCK THE PLANT FOOD ALREADY IN THE SOIL.

Much of the potash and phosphorus in agricultural soils is not available for crop growing because not in a soluble form. The active fermentation of fresh barnyard manure liberates carbon dioxide which acts as a solvent when combined with water. Certain low organisms like the bacteria and fungi are known to assist in dissolving rock particles and manure encourages their growth. The organic acids resulting from the decay of humus are also thought to have solvent

properties. Barnyard manure has been found beneficial to muck soils where drainage and liming have preceded it, for the introduction of countless bacteria in the manure hastened the decay needed in the muck before it could be cultivated satisfactorily.

BARNYARD MANURE AS A MULCH FOR CERTAIN CROPS HAS PROVEN A SUCCESS.

Where the retention of moisture during a critical period of growth is needed for some special crop, no better blanket can be found than stable manure. When rain falls, the soluble portions of the manure are leached into the soil below to feed the plant roots. When drought prevails the coating of manure effectually stops the undue evaporation of moisture from the soil without depriving it of aeration. Tomato and pepper plants in the garden or forcing house, late potatoes and cabbages respond to the manure mulch, while succeeding crops will also derive great benefit from the manure plowed under. It seems likely that the marked benefits found in top dressing meadows with fresh manure may be partly due to the mulching effects of the manure which has settled down around the grass crowns where it prevents excessive evaporation, through the hottest days of summer, as well as feeds the shallow rooted grasses by leaching in the spring and winter rains. **Without the machine spreading which properly distributes the mulch over meadow lands it would be well nigh impossible to secure uniformly good results.** Although barnyard manure is a valuable asset to American farmers if saved carefully and applied intelligently, in practice it suffers heavy losses in value from at least three sources, all of which are avoidable.

DEFECTIVE STABLE FLOORS AND LACK OF ABSORBENTS WASTE THE LIQUID MANURE.

Where ordinary earth is used as a stable floor, or the manure gutter has no better bottom, a surprising amount of the liquid excrement soaks away into the ground and is lost. Plenty of bedding will not stop this loss completely, for time is necessary to saturate the straw or other litter commonly used. Cut straw or sawdust will absorb the liquid portion more rapidly. Where planks are laid on top of earth for flooring there is a little improvement but usually some cracks are left between them and others are formed in a few years allowing the escape of liquid manure into the ground before it can be absorbed by bedding if any is used. Thoroughly tight floors and gutters should be the rule in every stable, and in addition there should be enough bedding or other absorbents used to take up all the liquid

excrement produced. If for sanitary reasons it seems necessary to remove the surplus liquids without waiting for them to be absorbed, a tight drain should be connected with the gutters and lead into an outside cistern or pit. It can then be applied to meadows through a sprinkling cart with good results, or else the drier manures from the barn may be stored in the pit where they will have a chance to absorb more of the liquid portion before use in the fields. The use of Portland cement makes it possible for every thrifty farmer to have good stable floors that will turn water and last a lifetime at a reasonable cost. A combination of matched plank and pounded clay may make an impervious floor but it is lacking in permanency.

LEACHING IN THE OPEN BARNYARD DEPRIVES MANURE OF ITS SOLUBLE COMPOUNDS.

Although the liquid excrements may be well cared for in the stable and bedding enough to absorb them be used, storing manure in an open yard for weeks or months where it will be exposed to rains causes frequent and heavy losses. As the rain water leaches through the mass it carries away much of the soluble portion into open ditches, brooks and rivers. This is particularly true where manure is carelessly piled under the drip of the eaves of farm buildings. The covered barnyard where no rain can enter, or the tight bottomed pit from which surface washing is turned away, are much better places in which to store manure. This loss can be almost entirely eliminated by hauling manure to the fields and spreading it evenly over the surface at frequent intervals of a day, two days or a week. Here leaching benefits the soil below and in the case of meadows brings marked improvement in the appearance of the grass and clover plants. There is little to fear from leaching in the fields except where manure is spread on top of ice and solid snow. The soluble compounds washed out of the coarse litter and solid excrement are mostly fixed in the soil, especially if it be a clay or loamy soil. The practice of piling manure in the field in small heaps during the winter, to be spread just before spring plowing, enriches one spot at the expense of the area around it, beside having the risk of loss from hot fermentation.

HOT FERMENTATION REDUCES THE VALUE OF MANURE BY THE LOSS OF NITROGEN.

The compounds of nitrogen in barnyard manure are the most valuable of its plant food constituents. They are also the most easily lost from the manure. Being unstable compounds they are changed by fermentation and ammonia is formed. This escapes into the air in

the form of ammonium carbonate, a volatile substance which is soluble in water. In the process of fermentation the oxygen of the air is required by the life processes of the bacteria causing the fermentation, and heat is liberated in the manure pile. Thus it is that when stable manure from horses or sheep is loosely piled, it grows hot and gives off a strong odor of ammonia. Sufficient packing and wetting to exclude the air reduces the hot fermentation to a minimum. The practical remedy is found where manure from all the farm animals is mixed and trampled down in a manure shed or covered barnyard. A flat topped pile well trodden down and moistened occasionally will also check hot fermentation. Various absorbents have been used to entrap the ammonia with success. Gypsum or land plaster forms with ammonia a more stable compound of nitrogen and prevents its escape into the air. Dry earth, muck, ground phosphate rock, superphosphate and kainit have all been used to prevent the waste of nitrogen by fermentation. Kainit and superphosphate have been found injurious to the hoofs of animals when used on the stable floors. Probably the fermentation of nitrogen compounds in the liquid manure begins very soon after it is voided. The odor of ammonia is often quite pronounced in a poorly ventilated stable on a winter morning. It is important that some good absorbent be sprinkled in the gutters or where the manure falls before the bedding is laid down, and thus save most of the nitrogen in the manure.

Beside those bacteria which break up the nitrogen compounds and liberate ammonia, there is another class which may destroy the nitrogenous part of barnyard manure and set free nitrogen gas. These bacteria do not need air or free oxygen for their life processes and consequently they may be found at work where hot fermentation is impossible. In cases where excessive applications of manure were made to the soil it has been found that a part of the nitrogen was lost by the action of these **denitrifying** bacteria. It is customary for some market gardeners to apply as high as 50 tons of rotted manure per acre to soil intended for early crops like cabbage which must mature before the heat of summer, when soil fermentations are most active. If it were not for the fact that the crop is sold for a fancy price, the waste of nitrogen attending such heavy applications of manure could not be justified. For all ordinary crops it is more profitable to apply manure in moderate quantities. **A light dressing frequently repeated is better for field crops than excessive applications with several years intervening.** With machinery adapted to spreading varying quantities per acre it becomes possible to regulate the application of manure to a nicety and secure the largest returns from its use.

REINFORCING MANURE.

Barnyard manure is not a perfect or complete fertilizer for all soils. Where grain farming has been practiced for many years without much attention to replenishing the phosphorus of the soil, the best results from using barnyard manure are not obtained until some form of phosphorus is added to the manure. The older cultivated soils of this country are often found deficient in phosphorus for maximum crop growing. The nitrogen of the soil may be maintained and increased by the use of barnyard manure and the growing of legumes which are able to utilize the free nitrogen of the air. Most soils contain stores of potash which become available fast enough for crop needs where barnyard manure decays in the soil and lime is used. But the phosphorus of barnyard manure added to that which slowly becomes available in many soils is not sufficient to balance or complete the plant food requirements of many crops. It has been shown by investigations at the agricultural experiment stations that when phosphorus is added to manure before it is applied the gain in crop production due to the addition is worth more than the cost of the phosphorus carrier added. The two best sources of phosphorus for this purpose are superphosphate, or acid phosphate, and the raw ground phosphate rock called "floats" from which the superphosphate is made. In the corn belt states where the decomposition of humus in the soil is more active during the summer season the "floats" added to barnyard manure undergo chemical changes which make the phosphorus available to crops more readily than in the soils of the Northern and Eastern states. The use of superphosphate brings better results financially where soils are more clayey and the summer season less favorable to soil fermentation. The phosphorus of superphosphate is mostly in a form immediately useful to agricultural crops.

Both carriers of phosphorus added to barnyard manure have been tested at the Ohio Experiment Station. Director Thorne writing in *Ohio Farmer* says: "A dressing of 8 tons of fresh manure per acre once in three years, equivalent to $2\frac{2}{3}$ tons annually, has given a total increase to the value of \$8.23 per acre annually, or \$3.08 for each ton of manure. . . . When acid phosphate has been used with the manure in the Station's experiments, the total value of the increase has risen to \$13.47 per acre annually, or to \$12.67 after deducting the cost of the phosphate, equivalent to \$4.75 per ton of manure. The acid phosphate has been more effective when used in combination with manure than when used alone. Each material has reinforced and supplemented the other."

Where "floats" are used in the stable as an absorbent, 1 pound per day for each animal will be sufficient to balance the manure for crops

grown in the ordinary rotation. Since acid phosphate is injurious to the hoofs of animals when sprinkled on stable floors, it is better to sprinkle it over the load just before drawing to the field or storing under cover, at the rate of 40 pounds per ton of manure. Steamed bone meal is another carrier of phosphorus which may also be used to balance manure where the soil is deficient in available phosphorus. The best results from the use of these materials are most likely to be obtained where the manure and phosphorus carrier are **thoroughly mixed and finely divided in applying them to the soil.** The manure spreader will do this to the best advantage.

The time at which barnyard manure is applied to the field intended for a particular crop is of considerable importance. The condition of the manure and the kind of soil also have some bearing on the net results obtained in any given crop. Where crops are grown in rotation the net result of the manuring for the entire rotation should be the deciding factor. Director Thorne illustrates this very clearly in the case of corn followed by wheat. "It has been found in practice that for wheat crops rotted manure should be applied as a top dressing, while corn is greatly benefited by plowing under fresh manure in the spring. At the Ohio Station corn which had received 8 tons of fresh manure per acre gave an average yield of 23 bushels per acre more than the yield of the unmanured land beside it. The wheat which followed the corn in the rotation without any further manuring or fertilizing yielded nearly 10 bushels per acre more than the unmanured land. Where the wheat land received its manure as a top dressing just before seeding, the manure having been kept in the barnyard all summer for this purpose, the yield of wheat averaged only 1-5 of a bushel more than the yield of wheat which followed the manured corn crop. In the director's own words, "while the manure was lying in the barnyard waiting for the wheat, it might have grown more than 20 bushels of corn without impairing its value for wheat production." In practice the exact time and condition for the application of barnyard manure to farm crops, in order to derive the greatest benefit from its use, cannot always be followed closely. It is a bulky, heavy fertilizer to handle and the expense of extra handling and storage, the danger of losses in value, and the convenience of the farmer, are likely to hinder the most effective application of it. However, the advent of the manure spreader has made it easier to approach something like a system which may conform to the following statements in regard to the time and conditions for the application of barnyard manure to certain crops.

Barnyard manure for meadows and pastures should be applied fresh and well scattered as a top dressing. On old meadows the work

may begin as soon as the last hay crop is cut and continue whenever the ground is firm enough to hold up the team and spreader until the grass begins growth in the following spring, but the sooner after haying the better the effect. The protection during dry weather in late summer and autumn and the leaching of the soluble plant food from the manure to the grass roots will stimulate the grasses into renewed growth before winter comes on. The top dressing of declining pastures ought to begin when the spring growth of grass has been cropped down. New grass and clover seedings are greatly benefited by top dressing as soon as the grain crop with which they are usually sown is removed. The young plants are not well established until they have the entire use of the soil. Finely scattered fresh manure brings to the young plants prepared food and lessens the dangers from drought. Many farmers are adopting the plan of top dressing new seedings of grass and clover because of the pronounced benefit to the first hay crop following. The idea that the drying of barnyard manure when scattered on a meadow robs the manure of strength is entirely erroneous. Experiments at the Cornell Station showed conclusively that thoroughly air dried manure did not lose its fertilizing constituents.

The amount to apply on meadows in order to secure good returns in grass are indicated by a timothy field which the writer saw recently. Two years ago it received **twelve** loads of good barnyard manure per acre applied during autumn and winter with a spreader. The hay crop of the following year was considerably larger. A year ago the owner applied **six** loads per acre and his crop of hay this year (1909) was by far the best the writer has seen. The beneficial effects on clover of manure plowed under for a previous corn crop have been noted by Mr. M. A. Crosby in *Ohio Farmer*. In Northern Michigan on a high sandy knoll it had been found difficult to secure a good stand of clover when the sandy loam of that section ordinarily grew clover well. The top of this knoll was given a good dressing of barnyard manure before plowing for corn in the spring. The clover seed was sown in the corn in August and covered lightly with a cultivator. When winter came the growth of clover on the knoll showed greater vigor than the rest of the field. When the clover was ready to mow the following summer, the marked difference in the stand and growth of the clover on the knoll where manure had been applied for corn, and the unmanured portion of the field, could be plainly noted as far as the field could be seen.

Cornell Experiment Station Bulletin 261 reports the influence of fertilizers, including barnyard manure, on the production of timothy hay when grown in a rotation which included three successive timothy

crops. Barnyard manure was applied at the rate of 10 and 20 tons per acre before seeding with timothy, and the plots were top dressed at the rate of 10 and 20 tons per acre after the second crop was cut. Calculating the value of manure at 50 cents per ton on the farm it was found that the net gain from the use of this fertilizer for timothy hay was greater than that from any of the other forms of fertilizer used.

Fresh barnyard manure is best to apply to fields intended for corn.

This crop is known as a gross feeder and is able to make good use of coarse raw manure plowed under. The time of application, the condition of the manure, and top dressing versus plowing under for corn have been studied at the Maryland Agricultural Experiment Station with the following results:

Where applications of fresh manure were compared with rotted manure on corn the average of two crops showed a gain of 10.2 bushels of grain and 725 pounds of fodder in favor of the manure fresh from the stable.

Where fresh manure was applied for corn in July, November, January and March the average yield for four crops showed a steady **decrease** in the yields from July to March applications of 25.3 bushels of grain or a little over 30 per cent. Where rotted manure was applied in July, November and March the decrease from July to March applications was similar and amounted to 10.2 bushels or 14 per cent.

The gain per acre from using fresh manure as a top dressing **after plowing** corn land was 10.9 bushels of grain and 550 pounds of fodder as an average of two crops.

A top dressing of **rotted** manure on land already plowed for corn resulted in a gain of only 0.3 bushel of grain and a loss of 100 pounds of fodder. These results are clearly in favor of fresh manure for corn, applied in summer or autumn if it is to be plowed under, or used as a top dressing after plowing in the spring.

An Ohio farmer writes thus to the National Stockman and Farmer regarding the time to apply manure for corn. "Three years ago I hauled out manure and spread on sod for corn all winter as made from the stables up to the first of March. Then came a thaw and a rainy spell, keeping it too muddy to get on the field till the first of May. Then I hauled out the rest of the manure and plowed the field. Where I hauled in winter up to March 1st there was much the best corn. I left a big strip where there was no manure. There was no difference in the corn where I hauled in May from where I put no manure."

Director Thorne of the Ohio Station says: "The fact that corn is usually planted on sod land makes it especially easy to manure this

crop; for the manuring may begin as soon as the hay is taken off and continued through the winter until time to plow the land, or even until time to plant. The only objections to top dressing for corn are that coarse manure interferes with cultivation and the weed and grass seeds carried in the manure add to the difficulty of keeping the crop clean. Many farmers who are following this method of handling manure have stated that manure spread on sod land in the fall produces a larger increase than that spread immediately before plowing, and this is to be expected; for the fall manuring encourages the growth of the grass during the late fall and early spring, and thus produces a larger mass of roots, which will improve both the fertility and the physical texture of the soil."

A New Jersey farmer writing for Rural New-Yorker, says: "We usually apply most of our manure to corn ground and turn it under. . . . Contrary to our established custom, we allowed ten or a dozen loads to accumulate in our barnyard during our busy week of corn planting. The following week we spread it on a small lot containing about an acre, after the corn was planted but before it came up. Never having had any experience in driving a heavy team and a still heavier loaded manure spreader over a newly planted field of corn, we awaited results with some anxiety. Our anxiety, however, was quickly dispelled, as the corn put in a marvelously prompt appearance, distancing and at the finish surpassing all our earlier planted fields, and this in the face of the fact that this field had been planted to corn the previous year. As far as we were able to note, no damage whatever followed the use of the spreader."

It would seem very evident from such testimony as the above that **the manure spreader is a valuable aid to securing large corn crops and may greatly lessen the difficulty of cultivation where top dressing is practiced.**

On fall sowings of winter wheat and rye (often accompanied by timothy seed) the manure should be well mixed with the surface of the seed bed. If fresh manure has been applied and plowed under for the previous crop this is partly accomplished in the plowing for the fall sown crop. If the soil has not been recently manured a top dressing of finely divided fresh manure or rotted manure should be given while fitting the seed bed. The effort should be to encourage the rye and wheat roots to feed near the surface before winter set in. Then less injury from heaving by frost will result and the top dressing also affords some protection to the young plants from the severity of the winter. **To properly top dress wheat fields for autumn sowing a manure spreader is almost a necessity,** for the manure needs to be spread evenly and uniformly over the entire surface of the field.

Barnyard manure may be beneficial to spring sown oats and barley if used judiciously. On soils lacking in humus and deficient in plant food, applications of manure plowed under for oats will improve the growth of straw and increase the grain yield. The application should not be heavy and coarse strawy manure is likely to interfere with the rise of capillary moisture in the soil should the season prove to be dry. Too much well rotted manure applied for oat crops will cause lodging of the straw and consequent loss. It is better to manure the preceding crop and allow the oats to have the residual benefit of the manure in the soil. Barley is subject to much the same principle in manuring. **A light top dressing of fine manure applied with the manure spreader** will be found beneficial on poor soils, especially where it is desired to start a clover and grass seeding with the crop of oats or barley.

Barnyard manure is generally very beneficial to potatoes, roots and garden crops. There are few soils that do not need some organic matter added in order to produce the best garden and root crops. Even black muck and dark loams are often in need of the bacteria contained in manure and the increased fermentation and chemical changes brought about by applying it compensate for its use. For potatoes fresh manure is best applied in the early autumn and plowed under to decay during winter and early spring. The ground should be replowed before planting in the spring and the manure thoroughly mixed with the soil. Rotted manure may be used with success before spring plowing for potatoes. Mangels and sugar beets are injured by fresh manure as is also tobacco, and the manure should be well decayed if applied in the spring before planting. The preparation of soil for potatoes as described above will be found excellent for most garden crops. Early cabbage, cauliflower, celery and onions may be given heavier applications of manure but it should not be spread in large chunks or forkfuls. Even though as much as 30 tons per acre be used **it should be broken and scattered in small particles**, then thoroughly mixed into the soil. Fresh manure used as a mulch for certain garden crops will be very useful in a drought. Well composted manure placed in the hills planted to melons, squashes and cucumbers will often make the difference between success and failure on upland soils. Poultry droppings mixed with the manure from other farm animals add to its value as a garden fertilizer.

It should be remembered that the kind of soil treated with manure exerts considerable influence in the results obtained. The foregoing statements will need some modifications for local conditions. It is hoped that the farmer's judgment will enable him to make the necessary modifications in practice.

THE MANURE SPREADER

Considerable emphasis has been laid by the writer on the ability of manure spreaders to tear manure apart and apply it evenly and lightly in a finely divided condition. This is the reason that increased efficiency can be justly claimed for machine spread manure over that spread in the ordinary way. Director Thorne of the Ohio Station is authority for the statement that eight loads of manure per acre applied with the spreader have about as great efficiency as twelve loads put on roughly with a fork. In writing for Ohio Farmer on this subject he says: "Another fault of the primitive method of manure distribution was the very imperfect manner in which it was scattered. Turn the fork as I would, there would be lumps of manure here and uncovered spaces there, thus getting an excess of manure in one spot and leaving another without any. But the investigations of our own and other experiment stations have shown that when manure is used in excessive quantities a large part of its effectiveness is lost, and thus the 15 or 20 tons of manure per acre which we then thought to be but a moderate dressing often produced less effect than half that quantity would have done if properly distributed. In fact, it is practically impossible to distribute manure properly by hand, and the attempt to do so increases the cost of distribution far beyond that of spreading by machinery. There can be little doubt that where there are 100 tons of manure to be distributed annually, the manure spreader will pay 25 to 50 per cent on its cost each year." Where eight loads spread by horse power can bring the same benefit that twelve loads do when spread by hand labor, it follows that a given manure production on the farm will cover 50 per cent more of the fields each season if the manure spreader is substituted for hand spreading. There are many farmers the country over who value barnyard manure highly, but do not have enough to cover but a fraction of the farm each year; consequently each field cultivated receives a good coating but once in several years. It has been shown that frequent light coatings of manure are more beneficial than the same amount applied once at intervals of several years. **With the aid of the manure spreader a larger acreage can be covered each year**, thereby lessening the periods between applications.

Nature's method of fertilizing the soil puts the falling leaves, grasses and weeds on the surface of the soil to be slowly incorporated as time goes on. Top dressing with barnyard manure parallels nature's method when the manure is well torn to pieces and each

particle falls by itself. In most cases this is impractical with hand spreading, but not so with the machine. The mulching effects of manure, and the benefits derived from leaching it close to the roots of plants have become more and more apparent to those farmers who have adopted machine spreading. Mr. C. E. Green writes in *Ohio Farmer*: "I have spread manure in growing corn with good results but I believe that with the spreader it might be put on the wheat crop with much profit, not only to the wheat in affording a mulch and protecting from the washing by rains, but in securing a better stand of grass or clover, a thing greatly to be sought. It might be at times that there would be a loss by the wash of rains, but close observation will show that the wash of the soil will not be nearly so great when protected by coarse manure or straw."

Mr. Chesney Hatch, an Indiana farmer, made a very practical demonstration of the increased efficiency of machine spreading for barnyard manure. The details are related by Allen N. Stewart in *Hoard's Dairyman*: "In 1905 he spread barnyard manure on 10 acres of corn ground with a spreader. He harvested 620 bushels of corn which he valued at \$248.00. On another plot of ground in the same field he spread barnyard manure on 10 acres by hand. He harvested 500 bushels of corn which he valued at \$200.00, **making an increase from machine spreading over hand spreading of \$48.00.** In each case he spread five loads per acre. You will note that there was a gain of \$4.80 per acre; or if figured in another way, on fifty loads of manure there was a gain of \$48.00."

While the gain in efficiency of the manure from machine spreading is great enough to warrant the investment, the convenience and economy of labor must be added if the whole truth is to be told. The manure spreader will cover an acre of ground **more quickly** than it is possible to do it by hand labor. The change from loading to spreading gives the driver a chance to rest some of his muscles so that he can show more speed in loading than he otherwise would if he had to unload with a fork in the field.

The labor problem in the United States has made the development of power machinery and horse drawn implements for farm use very rapid. Horse flesh and machinery are almost invariably cheaper than human labor in the progressive farming states.

The writer believes that next to our improved harvesting machinery the manure spreader is one of our greatest labor saving devices for the farm. Here is the experience of a New Jersey farmer given in the columns of *Rural New-Yorker*: "I consider these machines one of the greatest time and labor saving devices about the farm. . . . I live on a truck farm of 135 acres, and have about 400

tons of manure per year to handle. This is obtained direct from Philadelphia dealers by boat via Delaware River, and is landed during the fall in large heaps on the shore. In the winter this is carted and placed in smaller heaps at each end of the field on which it is to be used. In the early spring these heaps have to be thoroughly mixed and pulverized to facilitate spreading from the cart directly into the furrows. There is very little broadcasting done on the truck farms in this section. . . . Having had my own share of this work, I decided to lighten it if possible, and so after examination purchased a 30-bushel spreader of a standard make. At first I tried three horses to the machine, but later used four and obtained much better results. Now, with four horses and two men about half as much more manure may be spread in the same time two horses and the same two men did it formerly. Not only is time saved, but the laborious mixing of the heap is done away with, the spreader pulverizing the roughest manure as fine as possible. I would advise anyone having even a small amount of manure to spread to purchase one of these machines. The increased yield on all crops due to a more even distribution and thorough pulverization than can be obtained by other methods will pay the first cost of the machine."

It should be noticed in this connection that the manure spreader cannot be used for any other purpose, hence it is not likely to be tied up elsewhere when wanted for daily service. With proper attention to oiling and necessary repairs it is "always on the job." Where stables are built to allow of driving between the rows of stalls the spreader is an ideal cart for removing the manure daily from the stables to the fields. Where overhead litter carriers are used to clean stables, the spreader may be placed outside daily where the carrier bucket can be dumped directly into it, doing away with pitching the manure over the sides of the spreader box.

It is sometimes argued that the spreader will not tear coarse, stringy litter apart in spreading. The writer's experience has been that intelligent loading of the spreader box, keeping the sides filled level with the center and tramping with the feet if necessary, and loading from front to rear end, will greatly reduce this difficulty. A South Dakota farmer's experience reads thus: "My machine is the 50-bushel size and was guaranteed to give satisfaction, being shipped on thirty days' trial. It has filled every requirement so far. The first work done with it was to clean out a shed in which 100 to 200 head of range cattle had sheltered for about seven winters without bedding. This manure was packed so hard that it came out in large chunks, which were thrown into the spreader as they were, and I used most of it for top dressing a 3-acre garden. The spreader ground most of

the lumps to a powder, leaving a few small ones here and there. We could not have spread this manure by hand as repeated planking and disking did not crush many of the lumps that were left.

"The next trial was at the hog pens which had suffered from an overflow of the creek. Not having any other litter I used a lot of long slough hay to absorb the moisture, when the water went down. This made a fine mess, as I had previously thrown in some clay to level the floors thinking it would pack down hard. I told the man that I believed we were stuck, as we could hardly handle the stuff with forks. To our surprise it handled this oozy, stringy mass easier and better than it had the lumps."

Some skeptical persons say that the spreader will not work in winter when the ground is covered with snow, and that is the time when many farmers find it convenient to haul out their manure. If this were true it would hinder the daily use of the spreader in hauling manure directly to the field in winter. A Michigan farmer writes to Rural New-Yorker as follows: "As for working the spreader in the snow, it can be done in a reasonable amount of snow if one has the horse power. We have had the hardest winter for years, yet there was not a week at a time up to February that we could not use the spreader, and we have used it to haul the manure from fifty horses and cattle besides our own, also about two loads of wood ashes each week from a saw mill. In ordinary winters like the two preceding ones there would hardly be a week at a time when the spreader could not be used. We put traction bands on the rear wheels when the ground freezes. It will work all right in 3 or 4 inches of snow, or even in 6 inches if it is light, with two horses, but this makes the draft too heavy for steady work."

A New York state farmer also writes: "I know farmers who use their manure spreaders right through the winter here where it is sleighing all the time and have no trouble to use it in snow at least 1 foot deep. They consider their manure worth much more spread right from the stable on lands not too steep."

There are some primary considerations to be heeded in buying a manure spreader. The first one is the **draft**. A 2,600-pound team ought to run a 50 or 60-bushel spreader on level ground without undue exertion. Of course, the condition of the manure is bound to make some difference in the draft; so also is the condition of the ground over which the manure is spread. It is wise to provide for extra horse power under unfavorable circumstances such as top dressing plowed ground, and handling coarse, tough manure, but no farmer need buy a machine that is a horse killer.

The second essential point is the **simplicity**. Too many gearings,

cams and levers are likely to mean frequent repairs as well as add to the draft of the machine. The simpler the machine the better understood and operated by the ordinary man. Efficiency need not be sacrificed to mere simplicity, however.

A third desirable feature to be sought is **ease of controlling the amount to be spread per acre**. It frequently is desirable on rolling land to vary the amount spread to suit the particular needs of different portions of the same field. A machine which will allow the driver to change the speed of the delivery without stopping the machine or endangering the mechanism, has something in its favor.

Other features being equal, the machine which will **spread evenly** the **widest swath** is the most desirable.

EDWARD R. MINNS.

Cornell University, Ithaca, N. Y.

EXPERT TESTIMONY

On this and the following pages are given extracts from letters received from Directors and Professors in charge of State Agricultural Experiment Stations. These men are the foremost investigators and educators in the agricultural science, and their opinions and statements must be accepted as authority.

NORTH CAROLINA

DEPARTMENT OF AGRICULTURE.

Raleigh, Aug. 28, 1909.

Barnyard manure is one of the most valuable assets on the farm where considerable live stock is kept. The greatest benefit from this in increasing the yield of crops will be obtained from an even and uniform distribution of the manure, and this can only be had by the use of a good manure spreader. Where there is considerable manure it pays to have a spreader.

Very truly yours,

B. W. KILGORE,

State Chemist and Director, Farm Crops.

AGRICULTURAL EXPERIMENT STATION OF THE RHODE ISLAND STATE COLLEGE, KINGSTON, RHODE ISLAND.

Sept. 8, 1909.

Practically every station director will endorse the use of all the barnyard manure possible. Barnyard manure must be spread, whether plowed under or harrowed into the soil, and everyone knows that the manure spreader is the most economic means of accomplishing this distribution.

Very truly yours,

H. J. WHEELER,

Director.

OREGON EXPERIMENT STATION. CORVALLIS, OREGON.

Aug. 28, 1909.

A modern manure spreader will increase the manurial value to the farmer of his barnyard compost at least 50 per cent. Where much manure is to be handled we recommend the using of the spreader.

Yours truly,

JAMES WITTHYCOMBE,

Director.

SOUTH DAKOTA
AGRICULTURAL EXPERIMENT
STATION.

Brookings, S. Dak., August 2, 1909.

My opinion as to the value of the manure spreader over the hand method is that the manure spreader is indispensable. The advantage of having the manure scattered evenly is recognized by all. The advantage of having it done by machinery instead of by hand is a great one. The real work of handling, before the manure spreader came into use was the scattering of the manure in the fields. This has all been done away with in the advent of the manure spreader.

It is an advantage to the Western farmer to haul the manure out as it is made. Of course, there is a little loss by putting the manure upon the field before the frost is out, but the loss is not great enough to offset the expense that it would be to the farmer to haul it during the busy season of the year when the cost of labor is the highest. Every field will respond to an application of barnyard manure. It not only improves the fertility of the soil, but in a great many cases it improves the physical condition of the soil. I think people are liable to lose sight of the fact that the soil is sometimes in a poor physical condition. Much of the manure made in our cities is carted to some convenient dump pile and some is dumped in streams to be washed down during high water. It seems to me that the farmers who live close to these cities should secure the sweepings of the streets and the manure and have it put on their lands.

Yours truly,
JAMES W. WILSON,
Director.

STORRS AGRICULTURAL EXPERIMENT STATION.

Eagleville, Conn., July 30, 1909.

The manure spreader is, in my opinion, a farm tool which should be on every farm where stock is kept, at least where a dairy herd of ten cows or more are on the farm. While the use of the manure spreader does not add any plant food to the manure, yet it distributes the manure so uniformly that all parts of the soil are benefited by it. In my opinion the efficiency of stable manure is increased from 50 to 100 per cent by the daily use of the manure spreader and the daily removal of all the manure produced on the place to the fields.

Yours very truly,
L. A. CLINTON,
Director.

UNIVERSITY OF TENNESSEE
COLLEGE OF AGRICULTURE AND EXPERIMENT STATION,
KNOXVILLE.

August 25, 1909.

It is my opinion that the manure spreader is one of the most economical machines on the farm. It is a great labor and manure saver.

Yours very truly,
H. A. MORGAN,
Director.

UNIVERSITY OF MISSOURI
COLLEGE OF AGRICULTURE,
AGRICULTURE EXPERIMENT STATION.

Columbia, Mo., August 19, 1909.

The value of stable manure is only partially appreciated by the average farmer. Too many men still consider manure a nuisance rather than one of the most valuable of farm assets. But with the increasing value of farm lands the time is upon us when even on the best farms manure must be scrupulously saved, if the land is to pay a fair return upon its valuation.

It is, of course, impossible to place an accurate valuation upon a ton of manure on account of its great variability in composition, due principally to the manner in which it is kept, as well as to the material fed, the kind of animals, etc. However, for average farm manure a valuation of \$2.00 per ton is none too high. In other words, the application of a ton of manure will increase crop yields sufficiently under average conditions, to the value of at least \$2.00 and in many cases a great deal more than this. It can readily be seen therefore, that the man who has 150 tons of manure (an amount readily made on the average farm) his yearly income will be increased at least \$300.00 per year by its use.

With the average stock farm where a systematic change of crops is followed, and practically all crops are fed, it is perfectly possible to apply from 5 to 8 tons of manure to each acre of corn land. Many men are doing this. The result is an increase in the value of the product from each acre of from \$10.00 to \$16.00 during one round of a three or four-year rotation and in many cases much more than this. To do this readily it is necessary in most cases to carefully save this manure by feeding under open sheds or around straw stacks and then scattering the manure with a spreader.

The plan of feeding directly on the fields is a good one in many instances, but with a careful change of crops and the use of clover preceding corn, lot and shed feeding is usually more profitable and satisfactory. Such a system necessitates the use of a manure spreader if the greatest return is secured from the manure and if the greatest economy in handling the manure is attained.

The value of a manure spreader is usually thought to be in the saving of labor, but as a matter of fact there are two other reasons why a manure spreader should be used which are really of greater importance. The first of these is the greater return to be secured per ton of manure where it is put on evenly and rather thin as compared with the common practice of putting it on unevenly and usually only on the thinner spots. Results have shown very definitely that such is the case. The second is that where a man owns a spreader he will almost always take better care of his manure than he will where manure hauling is such a bugbear. Personally I think that these reasons for owning a spreader are really of greater importance than that of saving labor, although this is an important item on the modern farm.

I believe, therefore, that a manure spreader will pay on every stock farm of one hundred acres or more and in many cases on farms of much less area. I know of no other one thing which needs emphasis more strongly among the farming class than the necessity for the proper care and handling of manure.

Yours truly,

M. F. MILLER,

Professor Department of Agronomy.

TUSKEGEE NORMAL AND INDUSTRIAL INSTITUTE,
TUSKEGEE INSTITUTE, ALA.

Sept. 4, 1909.

The subject of barnyard manure is one of great importance, and the more it is intelligently discussed the more prominently will its many important sides be shown up, to the advantage of the wideawake farmer.

I think it is generally conceded by every farmer that there is no manure or fertilizer that builds up the land so rapidly and permanently as what we class as barnyard manure.

The question of handling such large quantities economically and their even distribution has been a matter of much concern. The more finely it is divided and the more evenly it is distributed, the more and better will be the results.

I believe the proper kind of manure spreader will do this work better, quicker and more economically than it can be done in any other way.

Yours very truly,

GEO. W. CARVER,
Director Agricultural Instruction.

THE AGRICULTURAL EXPERIMENT STATION,
STATE AGRICULTURAL COLLEGE,
FORT COLLINS, COLORADO.

Sept. 3, 1909.

Barnyard manure, and especially manure from stock corrals, is most valuable in this state. It should be understood, however, that it should be thoroughly rotted, for with our dry soil, the application of much manure with straw may be a detriment for some time. Manure spreaders are used very largely in our state and I have heard no serious fault found with them.

Sincerely yours,

L. G. CARPENTER,
Director.

AGRICULTURAL EXPERIMENT STATIONS,
FORT WORTH, TEXAS.

Sept. 4, 1909.

We get the most satisfactory results by spreading green barnyard manure on the soil without waiting for it to undergo much fermentation. It ought to be spread broadcast and then plowed under as soon thereafter as practicable. Of course, during summer months when crops are growing it must be applied to fields that are not in crops, or else heaped up and spread as soon thereafter as possible. A little acid phosphate added to the manure heap will help preserve it and add materially to its value, say 25 pounds of phosphate to a ton of manure, or 100 pounds to the ton, of phosphate floats. It is better, of course, to have the manure heap under a shed to prevent leaching and a little phosphate spread over the surface will prevent the escape of ammonia.

Yours truly,

H. H. HARRINGTON,
Director.

MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION,
AMHERST, MASS.

Sept. 3, 1909.

The value of barnyard manure is so fully appreciated by all our farmers and gardeners that we seldom think of discussing that subject. Certainly should we publish a bulletin on that subject we should be laughed at. This is not to say that some of our farmers do not handle their manure improperly. This is not to say that oftentimes it is so managed that a considerable proportion of its valuable constituents are lost. These phases of the matter we have discussed. Barnyard manure is valuable not alone because of the elements of plant food which it contains, but because of the fact that it supplies a large amount of humus, and thus helps to maintain the soil in proper physical condition; and because of the further fact that its use much improves the conditions in the soil to which it is applied for the activity of useful soil organisms.

I cannot take the time to discuss in full the care of manure. I will point out only that upon the average the liquid excrements possess about double the plant food value of the solid, and that a prime essential in good management is the careful preservation of every drop of liquid. As a rule, the best manner of insuring this result is to keep the animals upon a tight floor, either of plank or concrete, and to bed them liberally with straw or something of similar nature which will absorb the liquid.

In the second place, the most valuable constituent of our manures is nitrogen. This is subject to loss through escape into the air in the form of ammonia, which is produced as a result of fermentation or decay. It is desirable, therefore, if manure is to be preserved to prevent excessive fermentation. This result is best secured by keeping the manure compact and moist. The loss of ammonia can be still further guarded against by incorporating with the manure as it accumulates or in the stable a chemical which will combine with ammonia as it is formed to form a non-volatile compound. One of the best materials which can be used for that purpose is superphosphate plaster. Among other materials which are fairly efficient are superphosphate or acid phosphate, kainit and land plaster. These may be used in quantities ranging from about 1 to 2 pounds per animal daily.

It goes without saying that manure should not be exposed to the leaching action of heavy rains. If it must be piled in the open air it should be put in heaps of such size and shape that rains will not soak through them. Even with the most careful management it is almost an impossibility entirely to prevent loss in accumulating or preserving manure. Many, therefore, prefer to take it almost directly from the stables to the field, where it is immediately spread and if possible incorporated with the soil. For this purpose the manure spreader is an exceedingly valuable implement, doing the work much better as well as more cheaply than it is possible to do by hand.

Very truly yours,

WM. P. BROOKS.

Director.

OHIO AGRICULTURAL EXPERIMENT STATION,
WOOSTER, OHIO.

July 29, 1909.

The experiments of this station indicate the possibility of realizing a value of from \$3.00 to \$5.00 per ton for barnyard manure when properly handled. In order to realize this value three things are necessary:

First, the protection of the manure from rain or from heating under shelter.

Second, the reinforcing of the manure with some carrier of phosphorus, as our system of agriculture is such that not only is the soil exhausted of this element more rapidly than of others, but the manure which is returned to the soil is also relatively deficient in this element.

Third, the uniform distribution of the manure.

The effectiveness of the manure is very greatly increased by uniform distribution, and this is only to be accomplished by machine work, since when distributed by hand there will always be lumps of manure in one place which give an excessive quantity, and other places will receive none. We therefore regard the manure spreader as one of the most valuable implements on the farm.

Yours truly,

CHAS. E. THORNE,
Director.

KENTUCKY AGRICULTURAL EXPERIMENT STATION,
STATE UNIVERSITY,
LEXINGTON, KY.

Aug. 25, 1909.

I am sending you under separate cover a copy of our Bulletin No. 140, which will give my ideas concerning the use of farm manure. I will also add that I regard a good manure spreader as one of the best investments that a farmer can make, as it saves time, spreads the manure more evenly than can be done by hand, and therefore makes it much more efficient.

Yours very truly,

GEO. ROBERTS,
Chemist.

THE UNIVERSITY OF NEBRASKA
COLLEGE OF AGRICULTURE.
AGRICULTURAL EXPERIMENT STATION,
LINCOLN.

August 13, 1909.

No farmer will ever make a mistake in properly applying barnyard manure. The time has come when all farmers in the United States should take particular pains to save all the manure made on their farms and to carefully and properly spread this manure upon the land. There is no method which equals the use of a good manure spreader. Distribute it evenly and in small pieces so that the full value of manure may be retained on the land.

Yours truly,

C. W. PUGSLEY,
Agronomy and Farm Management.

VIRGINIA AGRICULTURAL EXPERIMENT STATION.

Blacksburg, Va., August 25, 1909.

Where a considerable quantity of manure is made on the farm, there is no question but that it pays to have a good manure spreader. Experiments have shown that the same amount of manure will bring larger returns spread thinly over a large area than if spread thickly over a small area. This is largely because the value of manure is due as much to the fact that it inoculates the soil with beneficial bacteria as to the plant food that it contains. A manure spreader distributes manure much thinner and more evenly than it can possibly be done by hand labor; hence, where the amount made is sufficient to justify it, an investment in a good spreader is amply justified.

Yours very truly,

S. W. FLETCHER,

Director.

STATE COLLEGE OF WASHINGTON.

AGRICULTURAL EXPERIMENT STATION,

PULLMAN, WASHINGTON.

Aug. 27, 1909.

The soil in this state is as yet so new that few of our farmers appreciate the value of farm manure as a fertilizer. We have found, however, by an extensive series of experiments at this station that most profitable results may be obtained from the use of manure even on soils so new and so rich in virgin fertility as are ours. For example, one plot of land which has been seeded to winter wheat continuously for ten years and has received 10 tons per acre of manure each year has given us an average yield of 43.8 bushels per acre, the average yield for the first five years being 43.2 bushels per acre and for the second five years 44.4 bushels per acre. An adjoining lot treated in exactly the same manner, except that it has received no manure, has given us an average yield of 27 bushels per acre, the yield for the first five years averaging 34.5 bushels per acre and for the second five years 19.6 bushels per acre. Of course, we do not recommend treating land continuously to wheat over such a period of time as this, but these experiments have shown the possibility of maintaining profitable yields under continuous cropping to wheat if barn manure is intelligently used in connection with the system.

Barnyard manure must be intelligently used in districts of limited rain fall, such as prevails in this state. Otherwise the manure fails to decay and the soils dry out very rapidly. The manure should be applied to the soil preferably in the fall, but in any event it should be scattered over the soil when applied and then disced into the ground so as to be well chopped up when the soil is plowed. Handled in this way manure can be used even in the extremely arid sections where the so called dry farming is practiced exclusively. Barnyard manure is the only economical means for preventing deterioration in soil fertility and is absolutely essential to profitable crop production on some of the soils in this state, particularly in regions of heavy rain fall, where the supply of available plant food is low because of excessive leaching in the soil.

Yours very truly,

R. W. THATCHER,

Director.

NORTH DAKOTA AGRICULTURAL COLLEGE.

AGRICULTURAL COLLEGE, N. DAK.

Sept. 1, 1909.

I wish to say that our people are coming to appreciate the value of manure spreaders in their common operations much more than they have done during the earlier history of the state. The addition of humus to soil, as well as the adding of fertility, is a prime necessity in every region that is farmed, and in dry land districts the humus supply is more urgent than in the more humid districts. Spreading manure on the fields with a manure spreader makes a much more even distribution than can be done by hand and the results are very much superior. Where drought conditions are present, uneven and a too heavy spreading of manure frequently causes heavy losses instead of added yields, as would be the case where good work in distribution is done. The demand for spreaders is increasing very rapidly in this state and I take it as one of the best indications that improved methods are gaining a foothold that can be found anywhere.

Yours truly,

J. H. SHEPPERD,

Dean and Vice Director.

OHIO AGRICULTURAL EXPERIMENT STATION.

Showing the increase per acre and value of same from the use of manure, variously treated and applied to land used in growing a three-year rotation of corn, wheat and clover.

Manure and Treatment	Average Increase per Acre			*Total Value of Increase	Net Value of Increase	
	Corn. 12 years.	Wheat. 12 years.	Clover. 9 years.		Per Acre	Per Ton of Manure
	Bu.	Bu.	Lbs.			
Yard manure, untreated.....	17.94	8.87	826	\$19.67	\$19.67	\$2.46
Stall manure, untreated.....	23.27	10.21	1,396	25.75	25.75	3.22
Yard manure and acid phosphate.	29.30	15.30	1,918	35.07	32.83	4.10
Stall manure and acid phosphate.	33.48	16.18	1,147	40.82	38.58	4.82

*Total value includes straw and stover, which are not shown in the table.

The acid phosphate is scattered over the manure in the stable or yard three or four times per week at the rate of 1 pound of acid phosphate per animal per day, or 40 pounds per ton of manure. The manure is applied at the rate of 8 tons per acre and plowed under for the corn crop, which is followed by wheat and clover without any further manuring or fertilizing.

In this table corn is computed at 40 cents per bushel, wheat at 80 cents, hay at \$8.00 per ton, stover at \$3.00 and straw at \$2.00.

In addition to the information given above I will say that we consider the manure spreader essential to the realization of the full effect of the manure, because of the greater uniformity with which it distributes the manure.

Yours truly,

CHAS. E. THORNE,

Director.

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